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ABSTRACT

The purpose of the present study was to examine the influence of workload prior to injury on injury (tissue type and severity) in professional soccer players. Twenty-eight days of retrospective training data prior to non-contact injuries (n=264) were retrospectively collated from 192 professional soccer players. Each injury tissue type (muscle, tendon and ligament) and severity (days missed) were categorised by medical staff. Training data were recorded using global positioning system (GPS) devices for total distance (TD), high speed distance (HSD; >5.5 m/s^{-1}) and sprint distance (SPR; >7.0 m/s^{-1}). Accumulated 1-, 2-, 3-, 4- weekly loads, coupled, uncoupled, EWMA 1:3 and 1:4 acute:chronic workload ratios (ACWR) were calculated for total distance (TD), and compared using a one-way ANOVA. Injury severity and ACWRs were compared using a bivariate correlation. There were no differences in accumulated 1-, 2-, 3- and 4- weekly loads and ACWR calculations between muscle, ligament and tendon injuries ($P > 0.05$). Correlations between each workload calculation and injury severity highlighted no significant associations ($P > 0.05$). The present findings suggest that the ability of accumulated weekly workload or ACWR methods to differentiate between injury type are limited using the present variables.

Key Words: Football, Training, ACWR, Load, GPS

INTRODUCTION

Soccer is a complex contact sport with high physical, technical and tactical demands at the elite level (1). Barnes et al. (2) highlighted the ever increasing high intensity demands of professional soccer in the modern game, with an increase in sprint distance of ~35% over a 7 season period. Due to the intense physical nature of the sport, a high level of injuries have been reported across a range of professional clubs (3). In particular, non-contact muscular injuries appear to be a significant issues for both coaching and medical staff, accounting for almost one third of all time-loss injuries in men's professional soccer (4, 5). Financially, the average cost of a first-team player in a professional team being injured for 1 month is calculated to be worth around €500,000 (6). Despite the increased body of knowledge and applied injury prevention strategies around non-contact injuries within soccer, the rate of these types of injuries continues to rise (7).

Within professional soccer, it is commonplace for sport science staff to monitor a range of variables across the training programme (8). The monitoring of training load (TL) on a daily basis is now commonplace in order to help facilitate the prescription of the correct 'dose' of TL to maximise adaptation and minimise injury risk. Measures of TL can be categorized into either external (i.e. exercise prescription by the coach) or internal (i.e. physiological stress imposed on the players) (9). The evolution in the accessibility of wearable technology within soccer has led to the widespread use of global positioning systems (GPS) to quantify athlete movements during training and match play (8). Common measures collected and monitored in elite soccer include; high speed distance covered (> 5.5 m/s^{-1}), acceleration/deceleration efforts and estimated metabolic power (8). Sports science and medicine practitioners can subsequently create individualised monitoring strategies based on the GPS data to feedback information to ensure observed TL is compliant with the training planned by the coaches.

Elite level soccer players typically sustain two injuries per season, resulting in 50 injuries within a squad of 25 players (4). It has been previously suggested that the incorrect application of workload can act as an external risk factor for injury in athletes (10). In particular, a sudden increase in the TL placed upon an athlete (i.e. 'spike') (11) or insufficient chronic TL stimulus (12) can contribute to an increased injury risk in athletes. There has been growing use of the acute:chronic workload ratio (ACWR) in order to monitor and prescribe appropriate TLs to athletes (13). The calculation involves the assessment of the current 1-week workload (acute) relative to the chronic workload (typically 2, 3 or 4 weekly average) (5). Previous research has used a combination of ACWR and/or accumulated weekly TLs to investigate the relationship with injury across a range of sports, including: rugby (14-19), Australian rules football (AFL) (20-26), American football (27, 28), handball (29), Gaelic football (30) and soccer (12, 31-37). Despite this growing body of research, there have been conflicting findings within the literature. One of the reasons may be due to the range of ways in which the ACWR can be calculated. Lolli et al. (38) argue the rolling average ACWR calculation can produce spurious correlations, which can be explained by mathematical coupling. Whilst others suggest calculating the ACWR using exponentially weighted moving averages (EWMA) could provide a more sensitive model to inform decision making (22). To avoid error associated with ratios, researchers have also compared the cumulative totals for each variable (35). To the authors' knowledge few studies have calculated and compared all of the above approaches using the same training data (22, 39).

Within soccer, each type of non-contact injury has its own unique incidence rate and severity (40). For example, anterior cruciate ligament typically occur once every 10,000 hours of training and cause a player to be withdrawn from training for around 200 days (41). Whereas, muscle injuries happen more often (~1 per 1000 hours) and cause the player to be removed from training and competition for around 24 days (40). Previous studies investigating the TL preceding injury have combined all non-contact injuries together, without distinguishing between the tissue type (e.g. tendon) and the influence of injury severity. Collating training data for each type of injury might improve our understanding of why players sustain particular injuries. If for example, the ratio of sprinting is different prior to muscle injuries when compared to tendon or ligament injuries, this could help inform our understanding of how the musculoskeletal system responds to the training currently employed by professional soccer teams. This could also inform the decision-making processes which assist how we prescribe training and implement risk management plans to reduce injury.

Therefore, the purpose of the present study was to examine the relationships of accumulated workloads, the ACWR using different methods and injury occurrence (severity and tissue type) in a large cohort of professional soccer players.

MATERIALS AND METHODS

Participants

Data were collected from professional soccer players (n = 192) from eight teams competing in recognised Union of European Football Associations (UEFA) leagues. Twenty-eight days of retrospective training and injury data was collected across both the 2015/2016 and 2016/2017 seasons. All clubs and players provided written informed consent to participate in the study, which was approved by the Institutional Review Board (IRB) at Liverpool John Moore's University (United Kingdom) and conformed to the recommendations of the Declaration of Helsinki and those outlined by Harriss and colleagues (42). Goalkeepers were excluded from the study due to the different nature of their playing activity.

Quantifying workload

Training load was quantified using GPS data collected from all on-pitch training sessions and matches during the in-season phase (Optimeye S5, firmware version 717, Catapult Sports, Melbourne, Australia). Each player was assigned their own specific device in order to avoid potential inter-unit reliability error (43). The device was worn inside a custom-made vest supplied by the manufacturer that was positioned across the scapula of the players. The number of satellites and horizontal dilution of position (HDOP) across all data collection were 14.0 ± 2 and 0.77 ± 0.03, respectively. The Catapult S5 GPS device has previously shown acceptable levels of both reliability (44) and validity (45) for velocity-based variables. The data collection procedures followed the guidelines for using GPS data in sport (43). Following each session, data were downloaded by a member of each sports science team using the manufacturers software (Openfield, version 1.14, Catapult Sports, Melbourne, Australia). The following variables were included for data analysis: total distance (TD), high speed distance (HSD; > 5.5 m/s^{-1}) and sprint distance (SPR; > 7.0 m/s^{-1}). The minimum effort duration for velocity-based variables was set at 0.4 secs in line with previous recommendations (46).

Injury quantification

Injury information was recorded using the clubs standardised internal medical procedures and were guided by the Munich Consensus statement (47). Non-contact injury was defined as an injury that involved no physical contact from another player and resulted in absence from participation in training with the normal group of players. Within each club, medical doctors and qualified physiotherapists diagnosed and recorded each injury tissue type (muscle, tendon or ligament) confirmed using ultrasound technology (47). Only injuries that were sustained for the first time were included in the final analysis. As such, data for subsequent recurring injuries were excluded. The severity of each injury was quantified as the number of days missed from training with main group of 'starting' players, involving full intensity and contact. Severity of each injury was also classified as either minimal (1 to 3 days missed), mild (4 to 7 days missed) moderate (8 to 28 days missed) or severe (>29 days missed) (32). All injury data was stored in a central database and then sent to the researchers via an encrypted platform.

Data analyses

Data were categorised into 7 day blocks (weeks) starting with the most recent day to the injury occurrence regardless of the week day. Accumulated 1-, 2-, 3-, 4- weekly loads were subsequently calculated using the sum of the daily load across the previous week(s). ACWR were calculated using the GPS derived data collected across the 28 day period prior to each injury. The last session recorded before the injury was classified as 'day 1'. From this day, the data were categorised into 7-day phases using a rolling average approach prior to this point (regardless of the day of the week). The acute training load was defined as the average 'load' for the 7-days prior to the injury. Both 'coupled' (C) and 'uncoupled' (UC) ACWR were calculated [52]. As a result, the chronic aspect of the ratio included either a) the average of the 2nd and 3rd week prior to the injury (UC ACWR 1:3); b) the 2nd, 3rd, and 4th week prior to injury (UC ACWR 1:4); c) the average of the 1st, 2nd and 3rd week prior to the injury (C ACWR 1:3) or d) the 1st, 2nd, 3rd, and 4th week prior to injury (C ACWR 1:4). In addition, the exponentially weighted ACWR was calculated according to the equation outlined by Williams and colleagues (48).

Statistical analysis

The software package SPSS (Version 24.0 SPSS Inc. Chicago, IL, USA) was used to conduct the statistical analysis. Prior to statistical comparisons assessments for normality and variance assurance were made. A one-way Analysis of Variance (ANOVA) was subsequently used to determine whether there are any statistically significant differences between the means of each injury tissue type (muscle, tendon and ligament) and each accumulated weekly load, coupled, uncoupled, EWMA (1:3 and 1:4), for TD, HSD and SPR. To examine the relationship between ACWR method and weekly accumulated workload on injury severity, correlations were performed using a bivariate analysis. The level of significance was set at $P < 0.05$. Confidence intervals (95% - CI) are provided alongside descriptive data (mean ± standard deviation (SD)).

RESULTS

Two hundred and sixty four non-contact injuries from eight professional teams were collected. One hundred and forty injury data sets were excluded due to inconsistent and/or missing data. Therefore, 124 lower limb injuries were included in the final analysis (muscle; n=79, tendon; n=28, ligament n=17). Descriptive data for each injury is presented in Table 1.

*****Insert table 1 near here*****

Influence of ACWR on injury tissue type and severity

Workload data for each ACWR method in relation to injury tissue type and severity are presented in Table 2. Regardless of the ACWR method used, there was no significant difference shown between injury tissue type for all workload variables ($P > 0.05$). In addition, there was no relationship found between ACWR methods and injury severity ($P > 0.05$).

*****Insert table 2 near here*****

Influence of accumulated weekly workload on injury tissue type and severity

Workload data for the different accumulated weekly loads in relation to injury tissue type and severity are presented in Table 3. There was no significant relationship found across the different accumulated weekly workload calculations (1, 2, 3 and 4 weekly loads) and injury tissue type for all workload variables ($P > 0.05$). In addition, there was no relationship found between accumulated workloads and injury severity ($P > 0.05$).

*****Insert table 3 near here*****

DISCUSSION

The purpose of the present study was to examine the relationships of accumulated workloads, the ACWR using different methods and injury occurrence (severity and tissue type) in a large cohort of professional soccer players. Regardless of the ACWR method used or weekly accumulated workloads, there was no observed differences in workload variables and each injury tissue type. In addition, there was no relationship found between workload variables and injury severity. The present findings suggest that workload data typically used by professional soccer teams may not be able to discriminate between injury type and/or severity.

The relationship between the ACWR and injury risk in soccer has been previously examined in the literature (12, 30-32, 34-36, 49). However, limited attention has been given to the ability of the ACWR to differentiate between different tissue types within non-contact injuries. Understanding if the different workloads associated with the training programme could result in each type of injury might have practical relevance for coaches who aim to minimise the injury burden within their team. The present study highlighted that the workload exposure across both ACWR methods and accumulated weekly loads were not different before either a muscle, tendon or a ligament injury. Considering that muscle, tendon and ligament, have unique mechanical intensity thresholds that initiate distinct temporal responses (50), it is logical to suggest that each injury could have its specific loading pattern prior to the injury (51). Indeed, previous research has noted that an acute increase in sprinting is associated with muscle-based injuries (12). This is supported by experimental research which demonstrate the transfer of force from ground to bone, from bone to tendon and from tendon to muscle is higher during sprinting actions (52). It was anticipated that muscle injuries would have occurred in individuals who underwent a 'spike' in sprint based activity in the week before the injury (31, 32). However, our results highlight that the training data for each player is homogeneous regardless of the type of injury. We also observed no differences in the ACWR (i.e., coupled, uncoupled or EWMA) for each of the workload measures included in this study (total distance, high speed distance and sprint distance) across each injury tissue type. This suggests that the exposure to use of the ACWR and accumulated weekly loads may not be sensitive to detect differences in non-contact injury tissue types in professional soccer players.

It is possible that the lack of differences observed in ACWR between each injury tissue type could be somewhat explained by the workload variables examined in the present study.

Soccer training and match-play includes an array of sport-specific skills (e.g. dribbling, passing and shooting) interspersed with repeated explosive activities and movements (e.g. high-speed running, sprinting, jumping and tackling) (1). Unfortunately, such movements could not be identified by the 'distance-based' variables used in the present study. Indeed, an increased amount of jumping and landing places additional stress on tendons and may injure the vulnerable junctional zones (i.e. the myotendinous junction and the enthesis). Due to the limited number of consistent variables returned from each club and the strict inclusion criteria in the present study, we were unable to quantify the amount of jumping and landing. Therefore, at present it is unclear if differential training stimuli result in a unique physiological response for each tissue type, subsequently influencing the types of non-contact injury sustained by players. This still remains an important question which will require further attention in future research. To do this, investigating other TL variables that might be able to capture the 'uncontrolled nature' of soccer training is warranted. The inclusion of accelerometer data might be able to provide a more complete picture of the different degrees of 'mechanical load' associated with different movements players experience during training and match-play (51). Indeed, considering the diverse physiological responses on bone, muscle, tendon and ligament tissue following different intensities of exercise (50), it is possible that a more detailed description of the overall mechanical and physiological load could show differences in the training stresses prior to different types of injury (51).

Previous authors have suggested that an ACWR 'sweet spot' exists (around 0.85-1.35), which could reduce the likelihood of injury and provide a positive training stimulus to prevent injury (53). This is supported by Colby et al. (21) who noted that players with a 'moderate' ACWR for sprint distance had a lower injury risk when compared to players who experienced 'extremely low' and 'extremely high' sprint ACWRs. This suggests that a rapid increase in sprinting within a short time period should be avoided to reduce the likelihood of muscle injuries (11, 18). This concept was also recently supported by Jaspers et al. [27] who note a lower injury risk was found for ACWR values between 1.00 and 1.25 in professional soccer players. The authors also noted beneficial effects for medium ACWRs showing a decreased injury risk in the subsequent week. This is in line with earlier research in different team sports suggesting that a gradual increase of sprint-based activity over time is likely to have a preventative effect on muscle injuries (12). These observations were, however, not supported within the current study. Conversely, almost all 142 non-contact injuries occurred within the suggested 'sweet spot' zone (53). This highlights that injuries in the current population occur regardless of the fluctuation in the workload experienced in the weeks preceding injury. Collectively, this further underlines the complexity of risk factors associated with injury as previously highlighted by Windt and Gabbett (10, 54). The authors highlight both internal (e.g., current fitness status, the players unique anatomy) and external risk factors (e.g., the playing surface or footwear/equipment used) interact and, ultimately result in an inciting event. In addition, whilst not discussed by Windt et al., genetic predisposition (55), muscle soreness (56), sleep quality (57), muscle architecture (58), and other stressors associated with competing at the elite level, are also likely to impact upon an individual's injury risk and warrant further attention.

Severe injuries remove players from match-play for lengthy durations, often resulting in significant psychological distress for the athlete (59), a reduction in the teams' performance (60) whilst also having financial implications for professional teams (6). It is, therefore, important that we aim to understand if the severity of injury may share an association with the workload undertaken by soccer players. However, few studies conducted to date have investigated the relationship between workload and the severity of injury (16, 17, 23, 31, 32). These previous studies have reported the severity of injury in one of 4 categories (minimal, mild, moderate and severe) associated with the number of days missed from training and/or games. However, categorising the injury severity in this way doesn't allow for the use of continuous data that allows researchers to run statistical analyses to study the effect of workload on injury severity. Therefore, the present study reported the absolute number of days missed from training/match play. Using this approach, our results indicated that none of the ACWRs or accumulated weekly loads for TD, HSD or SPR distance were associated with the severity of injury. This finding suggests that workload distance-based data, whilst important to monitor in a practical sense, has no associative value for the number of days a player will miss following injury. Even though the present study did not find any association, it is important that future research attempts to understand how training load interacts with other individual factors such as fitness level using advanced statistical techniques (54, 61). Whilst appreciating cause and effect is important, understanding the mechanisms which influence the individual and the outcome are vital if we intend to reduce the injury burden currently evident within professional soccer.

CONCLUSION

The present study is the first to investigate non-contact injury tissue type and injury severity in professional soccer players using a range of ACWR methods and weekly accumulated workloads. Regardless of the ACWR method used or weekly accumulated workloads, there was no observed differences in workload variables and each injury tissue type. In addition, there was no relationship found between workload variables and injury severity. The current findings reinforce that distance-based workload variables (i.e. TD, HSD, SPR) may not be sensitive to differentiate between different injury tissue types. Therefore, the use of ACWRs in isolation should, therefore, be acknowledged as a limited approach. As the physiological and biomechanical load-adaptation pathways have diverse response rates, there appears to be a need for studies to investigate the role of different degrees of physiological and biomechanical training load on different tissue types. Moreover, considering the physiological and psychological response to each training exposure in the context of the players' current fitness level and mental condition could allow us to gain more insight into why players get injured. Findings from such research is likely to have implications for the planning of training to prevent injury.

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Table 1: Descriptive information for injury incidence across all clubs

	Injury severity				Injury environment	
	1 to 3 d Minimal	**4 to 7 d Mild**	**8 to 28 d Moderate**	**>29 d Severe**	**Match**	**Training**
Muscle	18	18	33	10	30	49
Ligament	0	0	0	17	0	17
Tendon	4	9	11	4	10	18

Table 2: EWMA, coupled and uncoupled ACWR data for muscle, ligament and tendon injures

	Mean ± SD			95% Confidence Interval (lower - upper)		Min	Max	Range	One Way ANOVA		Correlation	
									F	P	Pearson	Sig.
EWMA ACWR TD												
Muscle	1.03	±	0.27	0.96	1.09	0.13	1.65	1.52				
Ligament	0.95	±	0.33	0.77	1.12	0.53	1.88	1.35	0.413	0.663	-0.055	0.542
Tendon	1.01	±	0.24	0.91	1.10	0.56	1.60	1.04				
EWMA ACWR HSD												
Muscle	0.95	±	0.29	0.88	1.01	0.12	1.66	1.55				
Ligament	1.00	±	0.39	0.79	1.21	0.42	1.75	1.32	0.107	0.898	0.031	0.732
Tendon	0.99	±	0.36	0.85	1.13	0.55	2.16	1.61				
EWMA ACWR SPR												
Muscle	0.93	±	0.42	0.83	1.03	0.12	2.07	1.95				
Ligament	0.99	±	0.57	0.68	1.29	0.12	1.98	1.86	0.079	0.924	0.013	0.888
Tendon	0.98	±	0.51	0.78	1.18	0.08	2.22	2.14				
1:4 ACWR [C] TD												
Muscle	1.06	±	0.32	0.99	1.14	0.20	1.96	1.76				
Ligament	1.04	±	0.35	0.85	1.22	0.59	2.23	1.64	0.2	0.819	-0.016	0.861
Tendon	1.03	±	0.36	0.89	1.18	0.36	2.18	1.82				
1:4 ACWR [C] HSD												
Muscle	0.99	±	0.39	0.90	1.09	0.02	2.26	2.23				
Ligament	1.08	±	0.30	0.92	1.23	0.58	1.57	0.99	0.156	0.856	0.010	0.911
Tendon	1.07	±	0.46	0.89	1.25	0.23	2.64	2.41				
1:4 ACWR [C] SPR												
Muscle	1.07	±	0.66	0.91	1.22	0.00	2.87	2.87				
Ligament	1.14	±	0.66	0.79	1.49	0.12	2.72	2.59	0.328	0.721	0.038	0.678
Tendon	1.01	±	0.61	0.77	1.25	0.00	2.64	2.64				
1:3 ACWR [C] TD												
Muscle	1.06	±	0.30	0.99	1.13	0.23	2.12	1.89				
Ligament	1.07	±	0.24	0.94	1.19	0.60	1.69	1.08	0.52	0.596	0.006	0.943
Tendon	1.00	±	0.28	0.89	1.11	0.38	1.92	1.54				
1:3 ACWR [C] HSD												
Muscle	0.99	±	0.37	0.91	1.08	0.03	1.96	1.93				
Ligament	1.09	±	0.23	0.96	1.21	0.72	1.55	0.83	0.112	0.894	0.014	0.877
Tendon	1.04	±	0.37	0.89	1.18	0.27	2.31	2.04				
1:3 ACWR [C] SPR												
Muscle	1.06	±	0.62	0.92	1.20	0.00	2.66	2.66				
Ligament	1.13	±	0.55	0.84	1.42	0.22	2.06	1.84	0.674	0.511	0.034	0.710
Tendon	0.96	±	0.51	0.75	1.16	0.00	2.37	2.37				

1:4 ACWR [UC] TD												
Muscle	0.50	±	0.25	0.45	0.56	0.06	1.83	1.77				
Ligament	0.53	±	0.51	0.26	0.80	0.22	2.38	2.16	0.107	0.898	-0.157	0.082
Tendon	0.52	±	0.30	0.40	0.63	0.13	1.36	1.23				
1:4 ACWR [UC] HSD												
Muscle	0.48	±	0.30	0.41	0.55	0.01	1.85	1.85				
Ligament	0.55	±	0.33	0.37	0.72	0.20	1.51	1.31	0.798	0.452	-0.032	0.729
Tendon	0.57	±	0.48	0.38	0.75	0.08	2.27	2.20				
1:4 ACWR [UC] SPR												
Muscle	0.63	±	0.66	0.47	0.78	0.00	3.66	3.66				
Ligament	0.79	±	1.08	0.22	1.37	0.03	4.56	4.52	0.506	0.604	-0.051	0.576
Tendon	0.58	±	0.50	0.38	0.77	0.00	1.95	1.95				
1:3 ACWR [UC] TD												
Muscle	0.89	±	0.42	0.79	0.98	0.10	2.32	2.22				
Ligament	0.86	±	0.45	0.62	1.10	0.37	2.38	2.01	0.06	0.942	-0.101	0.262
Tendon	0.86	±	0.51	0.65	1.06	0.20	2.79	2.58				
1:3 ACWR [UC] HSD												
Muscle	0.84	±	0.46	0.74	0.95	0.01	2.13	2.12				
Ligament	0.95	±	0.41	0.73	1.17	0.38	1.80	1.42	0.104	0.901	-0.049	0.596
Tendon	0.96	±	0.84	0.63	1.29	0.14	4.16	4.02				
1:3 ACWR [UC] SPR												
Muscle	1.26	±	1.46	0.93	1.60	0.00	7.67	7.67				
Ligament	1.21	±	1.07	0.65	1.78	0.10	4.56	4.46	0.653	0.522	-0.044	0.640
Tendon	0.94	±	0.75	0.64	1.23	0.00	3.58	3.58				

Footnote: EWMA; Exponentially weighted moving average, ACWR; Acute Chronic Ratio, TD, Total Distance, HSD; High Speed Distance, SPR; Sprint Distance, C; Coupled, UC Uncoupled, ACC Accumulative.

Table 3: Accumulated weekly workload data for injury tissue type and relationship with severity

Workload Variable	Mean ± SD			95% Confidence Interval (lower - upper)		Min	Max	Range	One Way ANOVA		Correlation	
									F	P	Pearson	Sig.
ACC TD Wk 1												
Muscle	26837	±	8818	24794	28880	4452	48860	44408				
Ligament	23483	±	4427	21124	25843	17311	33127	15817	0.881	0.417	-0.065	0.474
Tendon	24240	±	8016	21069	27411	8554	37452	28898				
ACC TD Wk 2												
Muscle	52124	±	12496	49229	55019	20944	84692	63749				
Ligament	45331	±	9585	40223	50438	26490	58996	32506	1.038	0.357	-0.047	0.607
Tendon	50727	±	13423	45417	56037	26314	74802	48488				
ACC TD Wk 3												
Muscle	76320	±	15704	72682	79959	34278	112768	78491				
Ligament	69165	±	13863	61778	76553	51389	91024	39635	0.706	0.495	-0.009	0.920
Tendon	74395	±	18406	67114	81676	37020	100297	63278				
ACC TD Wk 4												
Muscle	101072	±	18656	96750	105394	57936	140670	82734				
Ligament	95071	±	19990	84420	105723	52067	127476	75409	0.311	0.734	0.014	0.881
Tendon	96559	±	24174	86996	106122	45788	132093	86305				
ACC HSD Wk 1												
Muscle	1179	±	560	1050	1309	31	2679	2648				
Ligament	1127	±	469	878	1377	502	2293	1791	0.107	0.898	0	0.997
Tendon	1139	±	482	948	1330	330	1841	1512				
ACC HSD Wk 2												
Muscle	2431	±	891	2225	2638	482	4609	4127				
Ligament	2256	±	1096	1672	2840	1021	4807	3786	0.167	0.846	-0.002	0.980
Tendon	2322	±	891	1969	2674	699	3993	3293				
ACC HSD Wk 3												
Muscle	3563	±	1103	3308	3819	1258	6592	5334				
Ligament	3143	±	1281	2461	3825	1664	6214	4550	0.715	0.491	-0.113	0.211
Tendon	3514	±	1423	2951	4077	802	5780	4978				
ACC HSD Wk 4												
Muscle	4729	±	1346	4417	5041	1842	7706	5864				
Ligament	4188	±	1516	3381	4996	2110	7266	5156	0.816	0.445	-0.061	0.500
Tendon	4613	±	1975	3832	5394	1294	7570	6276				
ACC SPR Wk 1												
Muscle	247	±	195	201	292	0	965	965				
Ligament	246	±	155	164	329	41	552	512	0.017	0.983	-0.84	0.355
Tendon	234	±	161	170	297	0	743	743				

ACC SPR Wk 2												
Muscle	474 ± 289	407	541	2	1314	1312						
Ligament	512 ± 414	291	732	71	1437	1366	0.345	0.709	-0.186	0.038		
Tendon	509 ± 258	407	611	23	1068	1045						
ACC SPR Wk 3												
Muscle	695 ± 385	606	784	43	1705	1662						
Ligament	707 ± 508	436	977	193	1757	1564	0.246	0.783	-0.094	0.300		
Tendon	740 ± 426	571	908	23	1693	1670						
ACC SPR Wk 4												
Muscle	930 ± 504	813	1047	106	2572	2466						
Ligament	905 ± 548	613	1197	261	2071	1811	0.107	0.899	-0.001	0.992		
Tendon	953 ± 549	736	1170	92	2437	2344						

Footnote: ACC; Accumulated Workload, TD; Total Distance, HSD; High Speed Distance, SPR; Sprint Distance, C; Coupled, UC Uncoupled, Wk; number of accumulated weeks of workload data